

United States Department of Agriculture
Bureau of Entomology and Plant Quarantine

THE USE OF METHYL BROMIDE FOR THE TREATMENT OF QUARANTINED PLANT PRODUCTS^{1/}

By Lon A. Hawkins, Division of Control Investigations

As a treatment for living hosts infested with insect pests under quarantine regulations, fumigation with methyl bromide in many cases meets the requirements for an effective treatment which is noninjurious to the host for the purpose for which it is intended.

Methyl bromide is a gas at ordinary temperatures, its boiling point being 40.1° F. As a liquid it has a specific gravity of 1.732 and as a gas it is approximately 3.5 times as heavy as air. As commercially produced, methyl bromide is approximately 99.5 - 99.8 percent pure. It is soluble in most common organic solvents but is only very slightly soluble in water. In an impure state it is used in fire extinguishers in France and England.

The first use of methyl bromide in insect control was made in France, about 1932, when it was applied as a blanketing gas with ethylene oxide. As there were indications of its insecticidal value, however, it was then tested as a fumigant alone. Its first recorded use in this country against insects was by D. B. Mackie in 1935. Mackie carried on considerable work with it, both of an experimental and of a practical nature. He has shown that numerous fruits and vegetables and other commodities can be fumigated with methyl bromide with safety, and he has also used it for killing rodents and termites in California. Some of his results are given in his several publications on the subject.

Methyl bromide was used experimentally by this Bureau in the summer of 1936 in the fumigation of fruits and vegetables for the adult Japanese beetle, and the results obtained in this investigation indicated that it might be valuable against other insects affecting fruits, vegetables, and nursery stock. Since that time work has been taken up on the destruction of insects which are under quarantines, both Federal and State, on a number of plant products. This work has been carried on by A. C. Johnson, E. M. Livingstone, H. C. Donohoe, J. W. Bulger, Randall Latta, S. S. Easter, and H. H. Richardson, of the Division of Control Investigations, but most of it has been in cooperation with other divisions of the Bureau of Entomology and Plant Quarantine, various

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State departments of agriculture, shippers, railroads, nursery men, and others. The list of collaborators is too long for mention to be made of each, but the excellent cooperation received has contributed markedly to the success of the work. It is very much appreciated.

In cooperation with the divisions of this Bureau concerned, experimentation has been under way since 1936 on adults and larvae of the Japanese beetle, in developing a treatment for fumigating carloads of fruits and vegetables in the regulated area so that they can be shipped outside that area without danger of carrying live adult beetles, and in the treatment of nursery stock so that it will be freed of any infestation by adults or larvae. It was determined that in green string beans, white potatoes, northern-grown sweetpotatoes, lima beans, sweet corn, peppers, tomatoes, and a number of other types of green vegetables and fruits shipped in the living condition, the fumigant could be applied at a dosage sufficient to kill the beetles in the package without damage to the commodity. This investigation has been extended since its inception, and during the past summer, in cooperation with the various interested agencies, a method was developed for fumigation of produce in refrigerator cars for the adult Japanese beetle.

The method employed in truck-growing regions of New Jersey, Delaware, Maryland, and Virginia in 1937 to insure freedom from infestation of shipments of such commodities during the Japanese beetle flight period was to prefumigate refrigerator cars for fruit and vegetable shipment, screen them, and then free the fruits and vegetables from beetles by other methods before loading them. This involved fumigating and screening some 15,000 cars at considerable cost, whereas only about 4,000 of them moved out of the regulated area. It was decided that it might be practical to fumigate and screen only the loaded cars that were to be shipped out of the regulated area, eliminating the cost of prefumigation and screening in other cases. The cars destined for uninfested territory were therefore fumigated at diversion points and allowed to move from the shipping point possibly a day's run to this point without screens. In this way fumigation was localized and all was done at three points. The cars traveled under ventilation in the usual manner to the particular diversion point and were fumigated after the contents had been sold. In this work some 2,771 cars were fumigated during the past season. The dosage was 2 pounds per 1,000 cubic feet, or 5 pounds per refrigerator car having a capacity, including ice bunkers, of 2,500 cubic feet, and it was applied at a temperature of 70° F. or above. The fumigant was agitated by a blower for part of the time the fumigation was in progress -- sufficiently to mix it thoroughly with the air in the car. Tests of the efficacy of the method were made by artificially infesting 16 cars with approximately 45,000 Japanese beetles. There were no survivals after fumigation.

In connection with this work, one point which deserves consideration is the retention of methyl bromide by fumigated products. A cooperative project with the Public Health Service has been under way for the last year and a half on the amount of methyl bromide retained by fumigated plant products and the effect of ingestion of these products by warm-blooded animals. H. C. Dudley,

of the Public Health Service, has been carrying on this study and presented a paper on his work at the Richmond meetings. In general it has been found that only a small amount of methyl bromide is retained by most fumigated plant products tested -- considerably less than would be dangerous for ingestion.

A method of fumigating strawberry plants in field baskets, or packed in crates, for Japanese beetle larvae was worked out on a commercial basis and authorized. A fumigation room with apparatus for circulating the air-gas mixture throughout the room was developed, built, tested, and found satisfactory.

Extensive investigations on fumigation of nursery stock for Japanese beetle larvae, in which some 4,000 plants of 575 varieties, representing approximately 200 genera, were used, with a total of around 20,000 larvae of the Japanese beetle, show that complete mortality of the larvae can be obtained by fumigating at a dosage of 2-1/2 pounds of methyl bromide for a period of 2-1/2 hours, at temperatures of 63° F., or above. The treatment so far is limited to 8-inch pots or soil balls, but investigational work is under way on larger soil masses, in the hope of extending the treatment to the general run of balled and burlapped stock.

It is of interest to note that this treatment has been applied to 25 varieties of hydrangeas with no damage and in most cases a noticeable acceleration of growth. Ninety-two varieties of azaleas have been treated and only two of these have shown definite injury. This treatment has been authorized, and shipments of fumigated plants are being made at the present time.

Oriental Fruit Moth

Work with the oriental fruit moth, taken up at the suggestion of J. Carl Dawson, State entomologist of Missouri, in 1936, when a few small lots of peach nursery stock in which hibernating larvae had been placed were fumigated, was continued during the winter of 1936-37 with approximately 25,000 hibernating larvae of this insect. The larvae were in cocoons in corrugated paper, or had spun cocoons among twigs or in holes in small branches prepared for that purpose.

In carrying out this project it was necessary to design a fumigation box that was tight and that could be heated readily and brought up to a fairly constant temperature. Such a box was built of galvanized iron, insulated and equipped with a fan for mixing the methyl bromide with the air and an electric heater thermostatically controlled. The box was self-contained in that it was only necessary to plug it in in a light circuit to make it ready for use.

In the experimental work the cocooned insects were placed in among brush in the box in as nearly natural conditions as possible, and after fumigation most of the insects were placed at outside temperatures for a period to simulate natural conditions. Dosages of from 1 to 4 pounds were used, and it was found that 3-1/2 and 4 pounds of methyl bromide per 1,000 cubic feet

for a period of 4 hours gave a complete kill in all cases. Some 50 experiments were carried out with this treatment and there was indication that a lower dosage might be employed.

The process was tested out on nursery stock in connection with three commercial nurseries, one in Missouri and two in Maryland. In the tests in Missouri 26 varieties of nursery stock -- in all about 1,000 trees -- were treated. The dosages were 3 pounds for 5 hours, 3-1/2 pounds for 4 hours, and 4 pounds for 4 hours at approximately 70° F. The stock was stored and planted out with an equal number of checks that had not been fumigated, to determine the comparative effect of the fumigant on the trees. Somewhat similar experiments were carried on in Maryland. The plantings were inspected at intervals throughout the summer. In most cases there was apparently no effect that could be attributed to the fumigant. In some cases there was a stimulation of growth and in a few instances a retardation, the latter occurring particularly in some varieties of apples. There was less damage to apples at the lower dosage of 3-1/2 pounds than at 4 pounds, although in some cases a definite retardation of the rate of growth was noted in the fumigated trees, even at the lower dosage. The work is being continued during the present season with a probability that a lower dosage may be effective and possibly a lower temperature. As a result of the work so far, seven of the Western States have modified their State quarantines to admit nursery stock from infested areas when fumigated by this method, and stock is being treated and shipped commercially into these States.

Sweetpotato Weevil

In connection with the eradication of the sweetpotato weevil, experiments were begun in the summer of 1937 in devising a method for destroying the sweetpotato weevil in seed potatoes, and with the further idea of developing a method of treating potatoes for culinary purposes so that they could be shipped outside the regulated area with no danger of carrying the insect. This involved determining the time and dosage necessary at various temperatures to kill all stages of the insect on and within the sweetpotato and sweetpotato plants. This was done for several temperatures and complete mortality was attained at 70° F. and above with a dosage of 3-1/2 pounds per 1,000 cubic feet and an exposure of 4 hours. It was found rather easy to kill the weevil within the sweetpotato, but the effect on the host was rather disturbing. When sweetpotatoes were taken from the kiln where they were maintained at a temperature of around 50° F. and fumigated at these low temperatures, even when the dosage was only 10 ounces per 1,000 cubic feet, they were liable to break down. In some sizable experiments, involving on the whole a hundred bushels or more of sweetpotatoes, practically a complete breakdown occurred in the treated potatoes and only a slight deterioration in the control. It was found, however, that by raising the temperature of the sweetpotatoes to above 70° F. a few days before fumigation, treating them at this temperature, and then holding them for 2 or 3 days before bedding, this difficulty could be largely obviated. Two sizable experiments were carried on last year on a commercial basis with excellent results in that the fumigated potatoes produced an excellent crop of draws. Treatment with methyl bromide markedly accelerates the production of shoots

and new growth in sweetpotatoes. Approximately 2,000 bushels have been fumigated and planted this year in cooperation with 40 or 50 growers, with a view of getting the process on a commercial basis, and ironing out any flaws in the procedure.

White-fringed Beetle

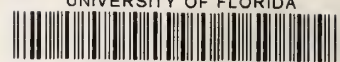
Investigations have shown that methyl bromide can be used in the fumigation of potted plants and greenhouse stock for the white-fringed beetle. A method has been developed for fumigating this stock at atmospheric pressures and at a temperature of 85° F. with a dosage of 1 pound of methyl bromide per 1,000 cubic feet. Out of 33 plants, mainly herbaceous perennials, some 24 can be fumigated without injury. Treatment of potting soil with a dosage of 40 cc per cubic yard gave a complete kill of the larvae of this insect at a cost of approximately 10 cents per cubic yard.

Fumigation of Miscellaneous Imported Plant Products

Experiments are under way in developing treatment for imported plant products, and this work so far is largely concerned with determining the effect of the fumigant on the numerous plants and plant products that are imported into this country in commercial quantities. It is planned to test the effect on the insect when sufficient numbers are available in commercial shipments of infested stock. When the effect on the host plant of fairly heavy dosages is known, the work can be completed rapidly when a sufficiently heavy infestation is found to furnish material for determining the effect on the insect.

In fumigation with methyl bromide, most of the evergreen plants and rose stocks, and nursery stock of such types, can be treated at a reasonably high dosage without injury to the plants. Some injury has been obtained with cacti and succulent plants. A number of experiments with Cattleya orchids which were infested with a coleopterous leaf miner were carried out during the past season, and complete mortality of the leaf miner was obtained by fumigation under 15-inch vacuum at a dosage of 3 pounds per 1,000 cubic feet, the orchids being in a dry condition. There was little or no injury to the orchids. Cipollini bulbs recently shipped from Morocco to New York were found infested with larvae of Exosoma lusitanica, a chrysomelid beetle not known to exist in this country, and it was possible to obtain some information on the effect of fumigation on both bulbs and insects. These bulbs were in dormant condition, and fumigation at a concentration of 4 pounds per 1,000 cubic feet in 15-inch vacuum for 2 hours did not injure them and killed all the larvae that were found on later inspection. About a thousand cases of these bulbs were fumigated.

Similar work in connection with shipments of green lima beans from Cuba, infested with Maruca testulalis, one of the bean pod borers, was carried out. Shipments arriving in New York were fumigated with a concentration of 4 pounds of methyl bromide per 1,000 cubic feet in a 15-inch vacuum for a



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period of 4 hours. Complete kill of the insects found in the pods has been obtained in a total of several thousand hampers. No injury to the lima beans was evident. The fumigation has been successful even at temperatures around 40° F. These results are being checked in Puerto Rico, where this insect is abundant, and sufficient data should soon be available for definite recommendations as to the treatment.

Studies are under way on the treatment of scale insects and certain other insect pests.

In general, methyl bromide seems to be specially adapted to the fumigation of plants or plant products which are transported and marketed in a living condition. It does not appear probable that it will take the place of other fumigants as an all-purpose fumigant but rather that it will extend the field for gaseous insecticides. It injures some plants and may accelerate or retard the growth of others. It appears to be a distinct addition to the means of combating insect pests, especially as a quarantine treatment.